DOCUMENT RESUME

ED 047 803 PS 004 443

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TITLE A Study in Training Nursery Children on Logical Operational Skills.
INSTITUTION West Virginia Univ., Morgantown.
PUB DATE 7 Feb 71
NOTE 10p.; Paper presented at the Annual Meeting of the American Educational Research Association, New York, New York, February 7, 1971

EDRS PRICE EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS Age Differences, Analysis of Covariance, *Cognitive Processes, Concept Formation, *Intellectual Development, *Logical Thinking, Number Concepts, *Nursery Schools, Preschool Curriculum, Testing, Training
IDENTIFIERS *Piaget

ABSTRACT

Piaget's organismic-developmental theory of intelligence was investigated in this study to determine the effectiveness of training middle class 3 and 4 year olds on two logico-mathematical structures: classification and seriation. Twenty-four children were divided into two main age groups (mean ages: 3 years 8 months; 4 years 5 months). Within each age category, children were randomly assigned to groups of four for seriation training, classification training, and a control group. To assess IQ and verbal ability, the Peabody Picture Vocabulary Test was utilized as a pretest-posttest measure; Piagetian tasks as a posttest only. Tasks included a seriation series of six problems and a classification series of seven problems. Three conservation tasks (quantity, number and area) were administered as far-transfer tests. Covariance analysis of the seriation task battery indicated there were significant treatment main effects and an age-treatment interaction with the high age seriation group indicating superior performance. Classification in both age groups was not found to be effective. Learning was not found to generalize to the far-transfer tasks. The age-related findings from this study were interpreted as supporting the stage-dependent aspects of Piaget's theory. (Author/AJ)

A STUDY IN TRAINING NURSERY CHILDREN ON LOGICAL OPERATIONAL SKILLS

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The renewed interest in early childhood education has generated research that points to this period as one of critical importance for intellectual development. Piaget's system provides a framework wherein a cognitive curriculum can be matched to the developmental status of the child. The developmental stages specify the right timing for acquiring specific knowledge. The curriculum can be derived directly from the child's developmental progression in pre-operational thought, creating a solid basis upon which to build subsequent concrete operations during the early grade school years. The foundation of the developmental process is equilibration, the mechanism responsible for the transition from a given level to a more advanced level. The equilibration model is recognized as superseding conventional learning theory and as a dynamic process that heavily depends on the right kind of experience at the right time for optimal learning. The child is viewed as the self-correcting monitor of his behavioral progress. Our study evaluated the effectiveness of preschool curricula based on the developmental sequence of classification and seriation concepts which according to Piaget are precursors to the child's conception of number.

The subjects consisted of twenty-four children attending the West Virginia University Laboratory Nursery School during the Spring of 1970.

Two groups of twelve children each were formed, one with a mean age of 3.8 and an age range of three years, two months to four years, two months; and another group with a mean age of 4.5 and an age range from four years, three months to five years, one month. Each age subsample included a classification training group, a seriation training group, and a control group, all chosen at random. A 3 X 2 analysis of variance design was thus generated with two age groups and three treatment groups.

The training sessions covered a four week period with three twenty-five minute sessions per week. Each group consisted of four children, and the groups were trained simultaneously by experienced preschool teachers. The sessions proceeded in a game-like way and the experimenter, whenever possible, called upon the children to correct each other. Objects were used in a manner to permit the child to manipulate them freely in order to discover relationships.

The training curriculum in classification skills was based on the developmental sequence of the first six levels of classification ability found in Kofsky's scalogram study (1966), and upon labeling-classification training sessions from a study by Shantz and Sigel (1967). The conceptual sequence used in the classification training were: 1) consistent sorting, 2) resemblance sorting, 3) some and all, 4) exhaustive sorting, 5) multiple class membership, and 6) the whole is the sum of its parts. The sessions for seriation were based on data from the Ypsilanti Early Education Program and the Preschool Curriculum Development Project, (Hooper and Marshall, 1968). The concepts trained in seriation were: 1) comparison between two sizes, 2) relative comparison, 3) serial correspondence, and 4) multiple seriation.

Pre-post test measures of I.Q. and verbal ability were utilized. These included the two forms of the Peabody Picture Vocabulary Test and Tests of

relational terms (Griffiths, Shantz and Sigel, 1967), which assessed the children's ability to understand the concepts, "same," "more," and "less." Curriculum specific tests included a classification task series composed of six problems based on Kofsky's (1966) scalogram sequence and a test of multiple classification from Shantz and Sigel (1967). A seriation task series of six problems was adapted from Whiteman (1964), Elkind (1964), and Coxford (1964), with a test of multiple seriation from Shantz and Sigel (1967). Far transfer (to the more advanced stage of concrete operations) was measured by three conservation tasks: quantity, area, and number (as adapted by Rothenberg, 1969).

All the Piagetian tasks were administered using a post-test-only design to avoid an interaction between pre-test and training. Since the children in the older seriation group had a significantly higher mean I.Q. score on the PPVT pre-test, an analysis of covariance was used with the PPVT pre-test scores as covariate.

The results of t-tests made on the pre-post tests of verbal ability indicate that only the low-age classification trained group improved significantly on both the PPVT and the tests of relational terms. The covariance analysis (see Table 3) of the classification battery revealed no significant effects. The analysis for the seriation battery, however, revealed a significant effect of treatment and an age level/treatment interaction. The low age seriation and classification trained groups were both significantly superior to their control. The high age seriation trained group was significantly superior to both the control and the classification trained group. Furthermore the performance of the high age classification trained group was lower than both their control and their low

age counterparts, although not significantly lower. None of the subjects in this study were able to conserve.

Classification training (refer to Table 1) appears to have the effect of facilitating learning of seriation in three-year-olds, but diminishes seriation skills in four-year-olds. The latter effect is in keeping with a result reported by Shantz and Sigel (1967), who obtained a decrement from pre to post-test by the classification trained group of five-year-olds on a test of multiple seriation. The seriation training (see Table 2) produced significant superiority in the learning of seriation concepts for both age groups. In addition, modest transfer of learning occurred when the seriation groups demonstrated uniform, though not significant, superiority over the classification trained children in the classification concepts.

Contrary to the results from previous training studies which dealt with logical operations (Sigel, Roeper and Hooper, 1966, Shantz and Sigel, 1967, Sigel and Olmsted, 1968) the far-transfer data indicate that none of the experimental subjects in this study were able to conserve after training. The children in this study were much younger than those in the studies mentioned. Since they were not able to conserve after training, it appears that they were not developmentally prepared to move from the pre-operational stage to the concrete operations stage, in spite of training.

The seriation training was obviously superior to the training in classification. A subjective analysis of the two curricula indicates that the seriation curriculum may have been more effective in the classroom situation. The experimenter found that training in this concept provided situations that enabled the children to create stories revolving around the

training objects. No such spontaneous creative activity was experienced with the classification training. In addition, the seriation training was directly related to the concepts being tested. Emphasis was placed on the training of serial correspondence, which satisfied two concepts: 1) the actual ordering of the objects and 2) the training of one to one correspondence according to size. The Fisher Exact Probability Test was run on the combined age groups and revealed significant superiority of the seriation trained group over the other groups on the subtest of serial correspondence. This is statistical confirmation of the importance of serial correspondence in the curriculum. The classification curriculum, on the other hand, did not provide direct training of the concepts emphasized by the tests. The ineffectiveness of this curriculum may be due to the emphasis placed on multiple-labeling rather than matrices and intersection tasks, which were emphasized in the test battery.

A major concern of our study has been to point out the salience of using the organismic-developmental view-point as the basis for a preschool curriculum. Piaget's system provides this framework wherein the child's needs may be met by preparing an environment geared to his developmental progression in operational thought so that solid structures can be formed. Training the pre-operational child in logical operations, specifically classification and seriation, is highly relevant since these concepts are thought to develop during the nursery school age period. Piaget claims that they are the precursors to the child's conception of number, which will develop during the period of concrete operations (a later stage). Training seriation has clearly been found to be effective with three and four-year-old children. However, since the training of classification

caused either no effect or detrimental effects in logical operation performance, it is possible that the nursery school child is not developmentally prepared for training in the concepts as used in this study. However, since classification training produced increased verbal ability, it is possible that a combined curriculum might be effective in increasing intellectual capacities.

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TABLE 1

Means and Standard Deviations of

the Classification Task Series*

	Task 1		Task 2		Task 3		Task 4		Task 5		Task 6		Task 7		Total Score	
	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.
Classification Training - I	1.00	--	1.00	--	.75	.43	2.50	.50	1.75	.83	.25	.43	1.00	.71	8.25	.43
Classification Training - II	1.00	--	.50	.50	.50	.50	2.25	.43	2.25	.43	0.00	--	.50	.87	7.00	1.58
Seriation Training - I	1.00	--	1.00	--	1.00	1.00	3.50	.50	3.00	.71	0.00	--	1.00	1.00	10.50	1.66
Seriation Training - II	1.00	--	.75	.43	.75	.43	2.75	.83	2.50	.87	.50	.87	.50	.50	8.75	1.92
Control Group I	1.00	--	75	.43	.75	.43	2.50	.87	2.50	.50	.25	.43	1.50	.87	9.25	2.28
Control Group II	1.00	--	.75	.43	1.00	1.00	2.25	.43	2.00	.71	.25	.43	1.00	.71	8.25	1.92

*Task Designations:
1 = Consistent sorting (Score range = 0-1)
2 = Exhaustive sorting (Score range = 0-1)
3 = Resemblance sorting (Score range = 0-1)
4 = Class inclusion (Score range = 0-4)
5 = Multiple class membership (Score range = 0-4)
6 = Class addition (Score range = 0-2)
7 = Multiple classification (Score range = 0-3)

TABLE 2

Means and Standard Deviations of

the Seriation Task Series*

	Task 1		Task 2		Task 3		Task 4		Task 5		Task 6		Total Score	
	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.	Means	S.D.
Classification Training - I	2.00	--	.50	.50	3.25	2.28	1.50	1.12	1.25	1.09	.75	.83	9.25	3.42
Classification Training - II	2.00	--	.50	.50	4.50	1.80	3.00	--	1.50	.50	.25	.43	11.75	2.38
Seriation Training - I	2.00	--	2.25	.83	7.00	--	3.00	--	3.00	--	2.50	.50	19.71	.83
Seriation Training - II	1.75	.43	.50	.50	5.00	1.58	2.50	.50	2.25	.43	.25	.43	12.50	2.60
Control Group I	2.00	--	.25	.43	4.25	2.95	2.75	.43	2.00	1.00	.75	.43	12.00	4.53
Control Group II	2.00	--	1.00	.71	2.25	1.92	.75	.83	1.25	.83	.25	.43	7.00	1.73

*Task Designations: 1 = Absolute comparison (Score range = 0-2)
2 = Relative comparison (Score range = 0-3)
3 = Successive comparison (Score range = 0-7)
4 = Additive seriation (Score range = 0-3)
5 = Serial correspondence (Score range = 0-3)
6 = Multiple seriation (Score range = 0-3)

TABLE 3.

Analysis of Covariance

Source	SS	d.f.	MS	F	Probability Level
Seriation Task Series					
Age	31.924	1	31.924	3.646	n.s.
Treatment	117.564	2	58.782	6.714	.01
Age x Treatment	81.067	2	40.533	4.629	.05
Error	148.850	17	8.755		
Classification Task Series					
Age	8.587	1	8.587	2.123	n.s.
Treatment	13.442	2	6.721	1.661	n.s.
Age x Treatment	.028	2	.014	.003	n.s.
Error	68.759	17	4.044		
ITPA - Visual-Motor Subtest					
Age	47.894	1	47.894	4.688	.05
Treatment	2.733	2	1.366	.133	n.s.
Age x Treatment	.169	2	.084	.008	n.s.
Error	173.685	17	10.216		
ITPA - Auditory-Vocal Subtest					
Age	247.041	1	247.041	1.702	n.s.
Treatment	474.750	2	237.375	1.636	n.s.
Age x Treatment	343.584	2	171.792	1.184	n.s.
Error	2611.250	17	145.069		